

AD-A063 628

BAKER (MICHAEL) JR INC BEAVER PA
NATIONAL DAM SAFETY PROGRAM. CRYSTAL DAM (VA 06904), POTOMAC RI--ETC(U)
SEP 78 M BAKER

F/G 13/2

DACW65-78-D-0016

NL

UNCLASSIFIED

1 OF 1
AD
A063 628



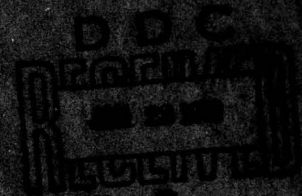
AD A063628

DDC FILE COPY

FREDERICK COUNTY, STATE OF VIRGINIA

LEVEL

PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



This document has been approved for public release and sale its distribution is unlimited.

PREPARED FOR
NORFOLK COUNTY BOARD OF SUPERVISORS
100 FREDERICK STREET
NORFOLK, VIRGINIA 23510

79 01 16 143

NICHOL BAKER, JR., INC.
SEWER, PENNSYLVANIA 15068

SEPTEMBER 1978

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

11

	<u>Page</u>
Brief Assessment of Dam.	1
Overall View of Dam.	3
Section 1: Project Information.	5
Section 2: Engineering Data	9
Section 3: Visual Inspection.	11
Section 4: Operational Procedures	15
Section 5: Hydraulic/Hydrologic Data.	17
Section 6: Dam Stability.	19
Section 7: Assessment/Remedial Measures	21

Appendices

- I. Plates
- II. Photographs
- III. Check List - Visual Inspection
- IV. Check List - Engineering Data



This document has been approved
for public release and sale; its
distribution is unlimited.

NAME OF DAM: CRYSTAL

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Crystal
State: Virginia
County: Frederick
Stream: Keckley Run
Date of Inspection: 20 July 1978

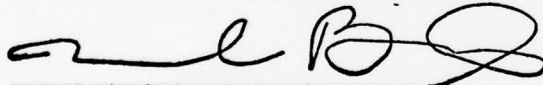
BRIEF ASSESSMENT OF DAM

Crystal Dam is an earthfill dam approximately 48 feet high and 750 feet long, owned and operated by the Shawnee Land Corporation for recreational use.

The visual inspections and analyses, made in July and August 1978, indicate deficiencies requiring emergency attention. The spillway is seriously inadequate. Hydrologic analysis indicates that the dam will be overtopped by both the Probable Maximum Flood and one-half of the Probable Maximum Flood. The one-half Probable Maximum Flood will overtop the dam by 0.3 feet for a duration of 1.3 hours.

The slide and wet areas on the downstream face, along with the marshy area near the toe, all indicate possible unstable embankment and foundation conditions which should be monitored closely and investigated further. Seepage control, spillway enlargement, erosion protection, and a detailed assessment of stability are items that should be investigated further by the owner.

MICHAEL BAKER, JR., INC.



Michael Baker, III, P.E.
Chairman of the Board and
Chief Executive Officer

SUBMITTED:

Original signed by
JAMES A. WALSH

James A. Walsh
Chief, Design Branch

RECOMMENDED:

Original signed by
ZANE M. GOODWIN

Zane M. Goodwin
Chief, Engineering

APPROVED: Original signed
by LEONARD C. GREGOR
Major Corps of Engineers
Acting District Engineer

SEP 19 1978 SEP 19 1978

Date:



NAME OF DAM: CRYSTAL

ADDITIONAL FOR	White Section	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Red Section	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Yellow Section	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Blue Section	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
COMMITTEE ON DAMS				
SEP 19 1978				

A

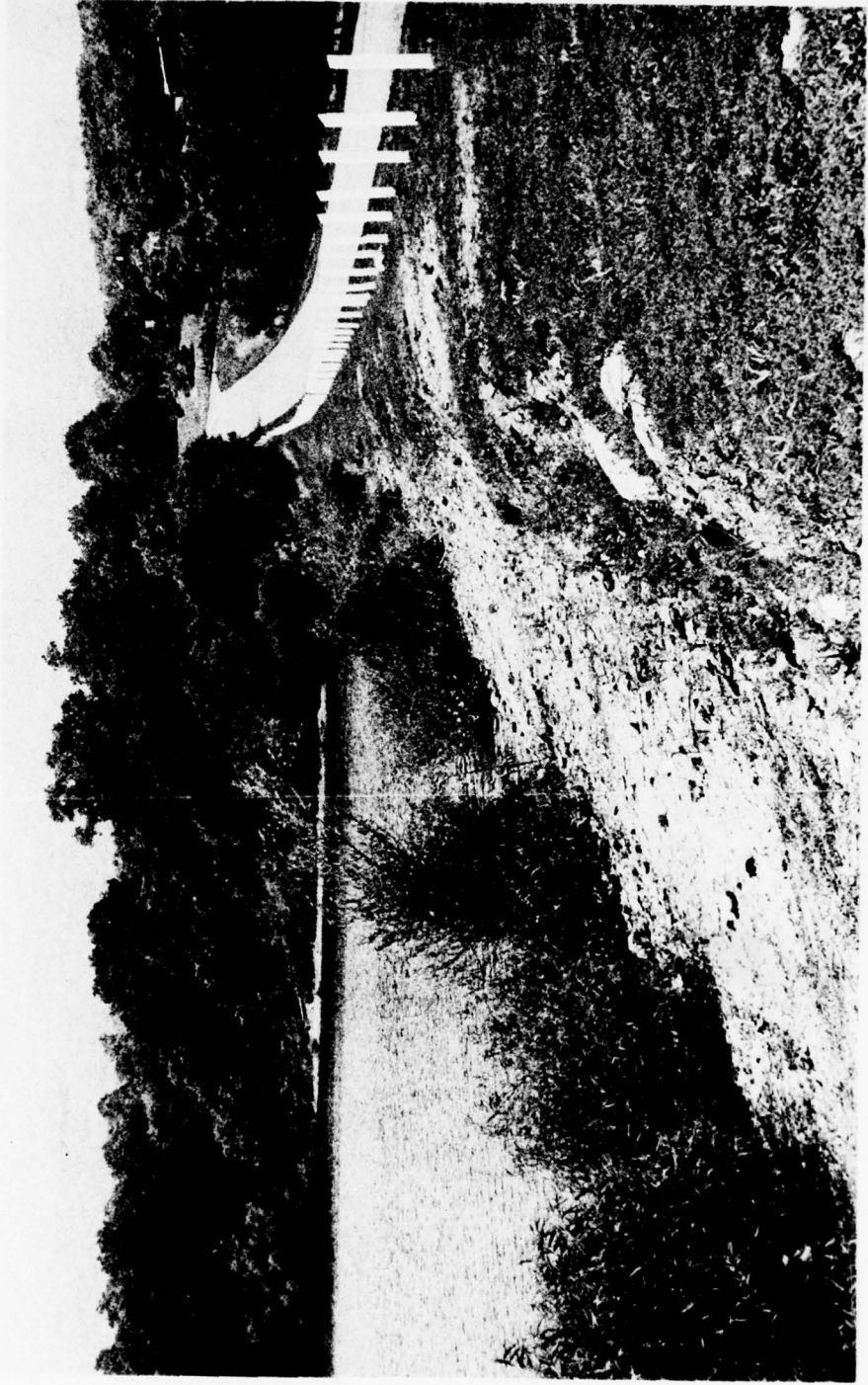
20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER VA 06904	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report National Dam Safety Program Crystal Frederick County, State of Virginia		5. TYPE OF REPORT & PERIOD COVERED Final
7. AUTHOR(s) Michael Baker, Jr., Inc. - Michael Baker, III (10)		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS (9) Final reptis		8. CONTRACT OR GRANT NUMBER(s) (15) DACW 65-78-D-0016
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Engineering District, Norfolk 803 Front Street Norfolk, VA 23510		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE (11) September 1978
		13. NUMBER OF PAGES 48
		15. SECURITY CLASS. (of this report) Unclassified
16. DISTRIBUTION STATEMENT (of this Report) (12) 45 p Approved for public release; distribution unlimited.		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) (6) National Dam Safety Program, Crystal Dam (VA06904), Potomac River Basin, Keokley Run, Frederick County, Virginia. Phase I Inspection Report.		
18. SUPPLEMENTARY NOTES Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dams - VA National Dam Safety Program Phase I Dam Safety Dam Inspection		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) (See reverse side) 440 795		



OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: CRYSTAL ID# VA 06904

SECTION 1 - PROJECT INFORMATION

1.1 General

- 1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.
- 1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams. The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

- 1.2.1 Description of Dam and Appurtenances: Crystal Dam is an earth fill dam about 750 feet long and 48 feet high. A two-lane paved roadway has been constructed across the 45 feet wide crest. The crest varies in elevation from about 1007.1¹ feet at the right abutment to 1027.6 feet near the left abutment. The height of the crest gradually decreases to an elevation of 1006.2 feet about 200 feet from the right abutment before it rises to elevation 1027.6 feet. Slope ratios are three horizontal to one vertical (3:1) on the upstream side and two and one-half horizontal to one vertical (2.5:1) on the downstream side. Since plans of the dam were not available for this inspection report, it is not known if a cut-off trench or zoning has been provided.

The principal spillway consists of a vertical 15 inch corrugated metal pipe capped by a metal strainer (intake structure) with one-half inch openings and a 15 inch corrugated metal pipe as a discharge conduit. The discharge is presently controlled by the

¹ All elevations are based on an assumed datum of 1000 feet at the top of the riser cap.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: CRYSTAL ID# VA 06904

SECTION 1 - PROJECT INFORMATION

1.1 General

- 1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.
- 1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams. The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

- 1.2.1 Description of Dam and Appurtenances: Crystal Dam is an earth fill dam about 750 feet long and 48 feet high. A two-lane paved roadway has been constructed across the 45 feet wide crest. The crest varies in elevation from about 1007.1¹ feet at the right abutment to 1027.6 feet near the left abutment. The height of the crest gradually decreases to an elevation of 1006.2 feet about 200 feet from the right abutment before it rises to elevation 1027.6 feet. Slope ratios are three horizontal to one vertical (3:1) on the upstream side and two and one-half horizontal to one vertical (2.5:1) on the downstream side. Since plans of the dam were not available for this inspection report, it is not known if a cut-off trench or zoning has been provided.

The principal spillway consists of a vertical 15 inch corrugated metal pipe capped by a metal strainer (intake structure) with one-half inch openings and a 15 inch corrugated metal pipe as a discharge conduit. The discharge is presently controlled by the

¹ All elevations are based on an assumed datum of 1000 feet at the top of the riser cap.

top of the riser pipe (elevation 999.2). An emergency gate for draining the reservoir has not been provided.

The emergency spillway is a small earth side channel spillway located at the right abutment. The approach channel is an asphalt and gravel area used as a boat launching area. A six feet wide eroded ditch adjacent to a paved road acts as the discharge channel.

- 1.2.2 Location: Crystal Dam is located on Keckley Run about one mile upstream from Clowser Gap, Virginia.
- 1.2.3 Size Classification: The dam classifies as an "intermediate" size structure based on its height of 48 feet.
- 1.2.4 Hazard Classification: Due to the lodge near the dam and the grocery store at Clowser Gap located downstream from the dam, many lives could be lost in the event of failure of the dam. Therefore, this dam is considered in the "high" hazard category as defined by Section 2.1.2 of the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.
- 1.2.5 Ownership: The dam is owned by the Shawnee Land Corporation.
- 1.2.6 Purpose: The dam is used for recreational purposes.
- 1.2.7 Design and Construction History: Construction was completed in 1956. Design and construction records were not available.
- 1.2.8 Normal Operational Procedures: No formal operating procedures are followed for this dam. Normal pool is controlled by the top of the riser pipe (elevation 999.2¹). Water rising above the top of the pipe is automatically passed downstream.

Excess flows are diverted through the side channel emergency spillway which has a crest elevation of 1001.8 feet.

¹All elevations are based on an assumed datum of 1000 feet at the top of the riser cap.

NAME OF DAM: CRYSTAL

1.3 Pertinent Data

1.3.1 Drainage Area: The dam controls a drainage area of 0.81 square mile.

1.3.2 Discharge at Dam Site: The maximum flow at the dam site through the spillway is not known.

Principal Spillway:

Pool level at emergency

spillway crest 15.5 c.f.s.

Pool level at top of dam 16.3 c.f.s.

Emergency Spillway:

Pool level at top of dam 540 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation(a) feet M.S.L.	Area acres	Reservoir			Length feet
			Capacity(b)		Watershed inches	
			Acre- feet			
Top of dam	1006.2	21.60	443	10.2	1725	
Maximum pool, design surcharge	-	-	-	-	-	
Emergency spillway crest	1001.8	18.65	354	8.2	1700	
Principal spillway crest	999.2	17.55	307	7.1	1680	
Streambed at center- line of dam	960	-	-	-	-	

(a) All elevations are based on an assumed datum of 1000 feet at the top of the riser cap.

(b) Storage capacity includes 307 acre-feet of storage below normal pool.

NAME OF DAM: CRYSTAL

SECTION 2 - ENGINEERING DATA

- 2.1 Design: No design data was available for this inspection report. The owner believes his copy of the plans was destroyed by fire in 1976, and he was unable to recall the name of the consulting engineer responsible for the design.
- 2.2 Construction: The only construction record available was the year of completion (1956).
- 2.3 Operation: Formal operating procedures are not used for this dam, consequently, operational history is not available.
- 2.4 Evaluation: No design, construction or operation data was available for this inspection report.

NAME OF DAM: CRYSTAL

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: Numerous deficiencies in the dam and appurtenant structures were observed at the time of inspection. Most of the problems require immediate remedial treatment, and several problems warrant corrective action before their situations worsen. Noteworthy deficiencies observed are described briefly in the following paragraphs. The complete visual inspection check list is given in Appendix III.

3.1.2 Dam: The following significant items were observed during the inspection and are shown in the Plates and Photographs of this report:

- 1) An old shallow slide, approximately 50 feet in length, was found near the crest of the dam on the downstream face. It is located approximately 250 feet to the left of the 15 inch diameter spillway outlet. The scarp is vegetated, but the slide mass has steep slopes and appears to be unstable. Seepage was not evident at this location.
- 2) A soft wet zone approximately 15 feet long and 10 feet wide was observed on the downstream face. This area is located about 10 feet to the left of the 15 inch diameter spillway outlet. Based upon the local datum, this area was at an elevation of approximately 978 feet. Although the soil was very soft, no active flow could be measured.
- 3) A large marshy area, approximately 150 feet by 100 feet, was located about 15 feet from the toe and to the right of the spillway outlet pipe. During the visual inspection, it was not possible to locate the source of this water.

NAME OF DAM: CRYSTAL

- 4) A wave-cut bench was evident at the normal pool elevation along the entire length of the upstream face.

- 3.1.3 Appurtenant Structures: The corrugated metal riser and outlet pipe were in good condition except for the heavy coating of surface rust on the metal strainer and corrosion at the outlet end.

The emergency spillway is severely eroded on its downstream sections where it parallels the road (Photos 3, 4 and 5).

- 3.1.4 Reservoir Area: No serious shoreline or gully erosion was observed.

- 3.1.5 Downstream Channel: The downstream channel is a well-maintained grassy trapezoidal channel. The alignment of channel with the outlet pipe is poor due to the sharp bend in the channel immediately downstream of the outlet. Further downstream, the channel is situated between two paved parking areas.

3.2 Evaluations

- 3.2.1 Dam: The four deficiencies noted previously warrant close observation and remedial action as follows:

- 1) The slide should be repaired and reseeded. An attempt should be made to determine its cause during the repair operation. No further investigation appears to be necessary at this time.
- 2) The wet area on the downstream face should be monitored to see if it becomes progressively worse and correlated with changes in the lake level. If the condition of this area significantly deteriorates, or if flowing water is observed; then a further investigation should be made.
- 3) The large marshy area should be further investigated to locate the source of its water. If it is

NAME OF DAM: CRYSTAL

determined that the reservoir is the source, then the piping potential of the foundation will need to be assessed. Correlation with lake levels is also recommended.

- 4) The wave-cut bench on the upstream face should be regraded and then protected from further erosion with riprap. No further investigation appears to be necessary.

3.2.2 Appurtenant Structures: Further investigation is required to determine if the primary spillway may be blocked with debris at some distance from the inlet and outlet ends.

3.2.3 Reservoir Area: The area does not require further investigation.

3.2.4 Downstream Channel: The channel does not require further investigation.

NAME OF DAM: CRYSTAL

SECTION 4 - OPERATIONAL PROCEDURES

- 4.1 Procedures: No formal operating procedures are used since this is a recreational structure, and there are no controls for water regulation and discharge.
- 4.2 Maintenance of Dam: The dam is privately owned and maintained by the Shawnee Land Corporation. The dam and downstream area are landscaped, and the grass is frequently mowed. However, large trees are included in the landscaping of the downstream slope.
- 4.3 Maintenance of Operating Facilities: The riser and outlet pipe though uncontrolled, are the only operating facilities. There were no debris or obstructions at the inlet and outlet ends. However, the lake level is above the crest of the inlet and the pipe may be clogged at some distance from the ends.
- 4.4 Warning System: At the present time, there is no warning system or evacuation plan in operation. It is recommended that the owner immediately prepare and display a formal emergency procedure to all maintenance personnel. This should include:
- 1) Who to notify, including public officials, in case evacuation from the downstream area is necessary.
 - 2) Procedure for evaluating inflow during periods of emergency operations. Staff and precipitation gauges could be used for this purpose.
- 4.5 Evaluation: Maintenance of dam is good except for tree and brush removal and the existence of animal burrows.

NAME OF DAM: CRYSTAL

SECTION 5 - HYDRAULIC/HYDROLOGIC DESIGN

- 5.1 Design: Design plans and calculations were not available for this report.
- 5.2 Hydrologic Records: None were available.
- 5.3 Flood Experience: According to the owner, the rainfall resulting from Tropical Storm Agnes in June 1972 caused the reservoir level to rise to the crest of the emergency spillway.
- 5.4 Flood Potential: Performance of the reservoir by routing the Probable Maximum Flood (P.M.F.), one-half P.M.F., and the 100 year flood hydrographs through the dam is shown in Table 5.1.
- 5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1, paragraph 1.3.3.

Regulation of the flow from the reservoir is automatic. Normal flows are controlled by a 15 inch corrugated metal riser pipe at an elevation of 999.2.¹ Water flows through the dam in this 15 inch corrugated metal pipe. Water also flows through the dam through an ungated earth side channel emergency spillway (crest elevation 1001.8 feet), in the event, water in the reservoir rises over the spillway crest.

Outlet discharge capacity, reservoir area and storage capacity, and hydrograph and routing determinations were computed through the use of field measurements and U.S.G.S. 7.5 Minute Quadrangle maps. The routing of the hydrograph for P.M.F., one-half P.M.F., and 100 year flood began with the reservoir at normal pool elevation.

- 5.6 Overtopping Potential: The probable rise in the reservoir and other pertinent information on the reservoir performance in various hydrographs is shown in the following table:

¹All elevations are based on an assumed datum of 1000 feet at the top of the riser cap.

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Hydrograph			
	Normal	100 Year	$\frac{1}{2}$ P.M.F.	P.M.F.
Peak flow, c.f.s.				
Inflow	0	357	2127	4254
Outflow	0	27	1188	4184
Peak elev., ft. (a)	999.2	1002.0	1006.9	1008.4
Emergency spillway				
Depth of flow, ft. (b)	-	0.3	4.6	6.1
Avg. velocity, f.p.s.	-	2.4	9.9	11.4
Non-overflow section				
Depth of flow, ft. (b)	-	-	0.3	1.6
Avg. velocity, f.p.s.	-	-	2.4	5.6
Tailwater elev., ft.	-	-	-	-

- (a) Elevations are based on assumed datum of 1000 feet on top of the riser cap.
- (b) Average depth of flow. Duration of overtopping for P.M.F. and $\frac{1}{2}$ P.M.F. is 3.9 and 1.3 hours, respectively. Emergency spillways passes 40 percent of the P.M.F.

5.7 Reservoir Emptying Potential: No means presently exists to draw the reservoir level down below normal pool.

5.8 Evaluation: Hydrologic and hydraulic determinations of the project as computed for this report indicate that the spillway capability is seriously inadequate because it will not pass either the P.M.F. or one-half P.M.F. The spillway will, however, pass the 100 year flood.

It should be indicated that conclusions pertain to present day conditions, and that the effect of future development on the hydrology has not been considered.

NAME OF DAM: CRYSTAL

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: Outcrops were not found during the field inspection. Design reports or drawings describing foundation and abutment conditions were not available.

6.2 Stability Analysis

6.2.1 Design Data: Stability calculations or other design data were not available; therefore, the structural stability of this dam is based on the visual inspection.

6.2.2 Operating Records: The structure has no instrumentation for indicating movements. Annual inspection reports that would indicate deteriorating conditions, if any, were not available.

6.2.3 Post-Construction Changes: It is not known if post-construction changes have been made, since the design plans are not available.

6.2.4 Seismic Stability: The dam is located in Seismic Zone 2, therefore, the dam is considered to have no hazard from earthquakes provided static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: The dam appeared to have been constructed with slope ratios of 2.5:1 on the downstream side and 3:1 on the upstream side. No tension cracks were observed. Evidence of an old shallow slide was observed on the downstream slope, about 250 feet to the left of the outlet pipe. The vegetated scarp is located near the crest of the dam and has a length of about 50 feet. The slide mass below the scarp appeared to be unstable with steep slopes. Seepage was not noticed at this location. It is recommended that this area should be repaired and an attempt be made to define the failure surface and cause of the slide during the repair work.

A soft wet zone about 15 feet long and 10 feet wide was observed on the downstream slope, approximately 10 feet to the left of the outlet pipe. The elevation of the wet zone was estimated at 978 feet. Although no flow was measured at the time of the inspection, this area should be monitored to prevent a worse condition

NAME OF DAM: CRYSTAL

from going unobserved. If flow is observed, further investigation by the owner will be necessary to define the phreatic surface, and assess piping potential and slope stability.

The 150 feet by 100 feet marshy area located about 15 feet beyond the toe to the right (when facing the upstream slope) of the outlet channel represents an undesirable condition that requires further investigation. The source of the water in this area could not be determined by visual inspection. Therefore, the purpose of additional investigation by the owner would be to determine its source. If the source is found to be the reservoir, then it will be necessary to assess piping potential through the foundation.

NAME OF DAM: CRYSTAL

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

- 7.1 Dam Assessment: There are findings, as a result of this inspection, that indicate deficiencies requiring immediate attention. The most urgent of these items is the inability of the emergency spillway to pass either the P.M.F. or one-half of the P.M.F.

Although no flowing water was found in either of the wet areas, their presence dictates close monitoring and further investigation of their cause.

- 7.2 Recommended Remedial Measures: The inspection revealed certain items of rehabilitation or other work which should be implemented immediately by the owner. These are:

- 1) Install an outlet system that will empty the reservoir.
- 2) Investigate the possibility of enlarging the spillway to pass the P.M.F. without overtopping the dam.
- 3) Repair and reseed the slide near the crest of the dam and assess the cause of the slide. A stability analysis may be necessary.
- 4) Monitor any changes in the soft area on the downstream face near the spillway outlet pipe. If flowing water is observed, further investigation is necessary to define the phreatic surface and assess piping potential and slope stability.
- 5) Investigate the large marshy area below the toe to locate the source of this water.
- 6) Regrade and place riprap on the upstream face of the dam to protect against future erosion.
- 7) Remove any trees growing on the dam, and mow the grass periodically to make visual inspections more effective. Remove brush and debris from downstream outlet channel.
- 8) Numerous animal burrows on the downstream face should be filled and reseeded. The animals should be trapped or exterminated.
- 9) Investigate the existence of any blockage in the primary spillway.

NAME OF DAM: CRYSTAL

A warning system should be devised that will alert downstream occupants to evacuate when the reservoir level approaches the top of the embankment. The downstream occupants should be advised to evacuate during storms that coincide with the U.S. Weather Bureau's flash flood warning system.

NAME OF DAM: CRYSTAL

APPENDIX I

PLATES

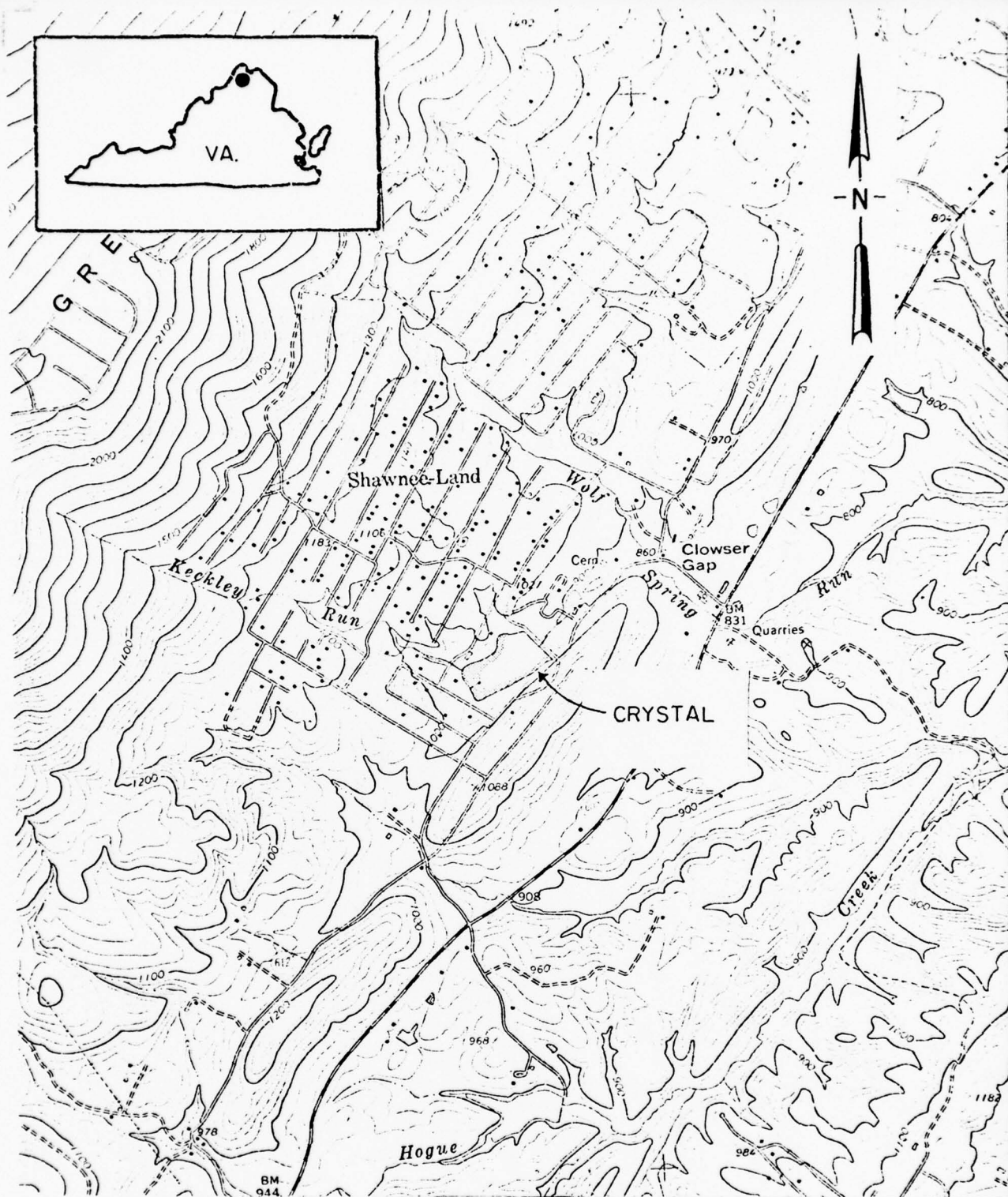
CONTENTS

Location Plan

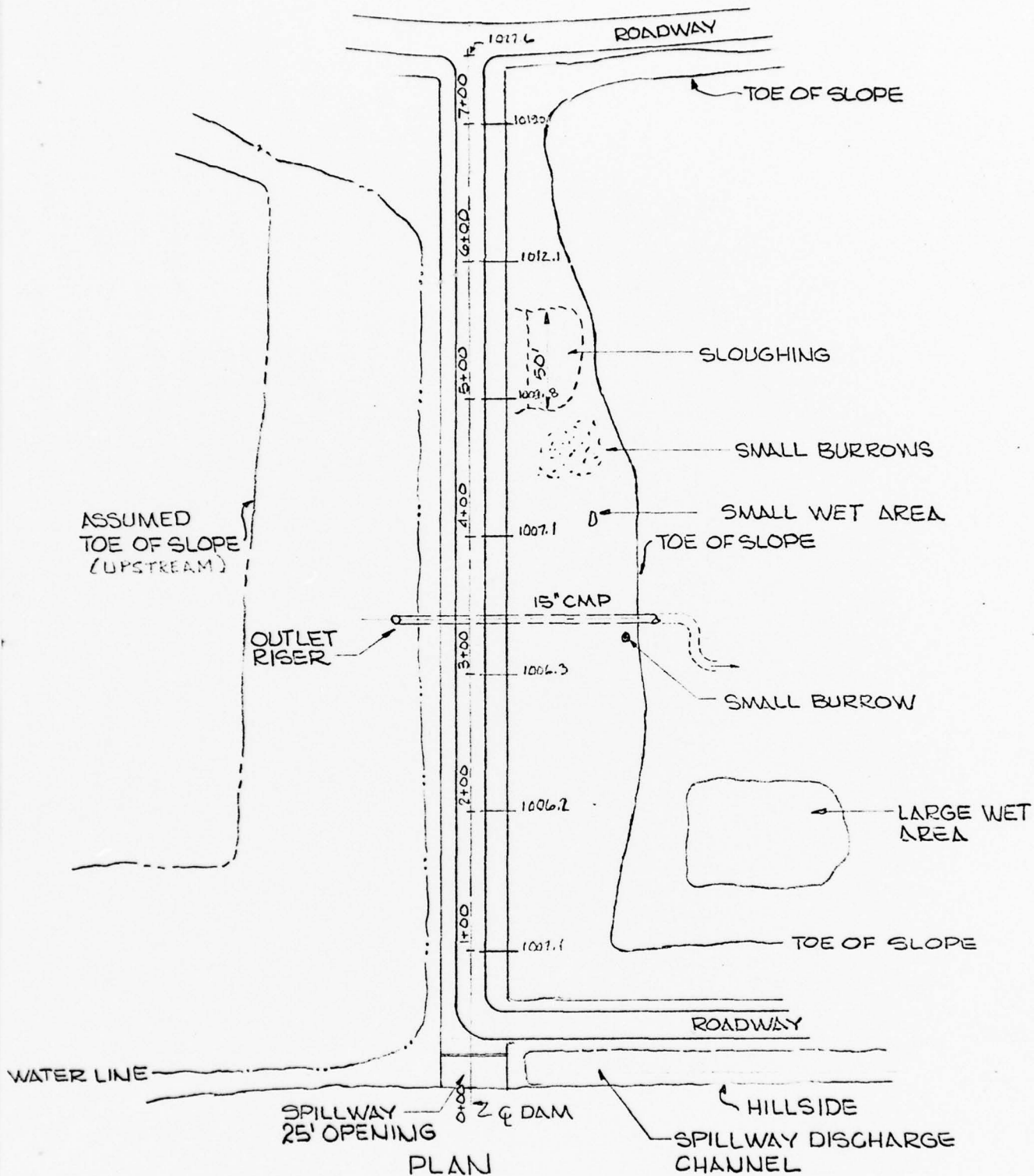
Plate 1: Plan of Dam (Michael Baker, Jr., Inc. Sketch)

Plate 2: Typical Section Through Embankment
(Michael Baker, Jr., Inc. Sketch)

NAME OF DAM: CRYSTAL



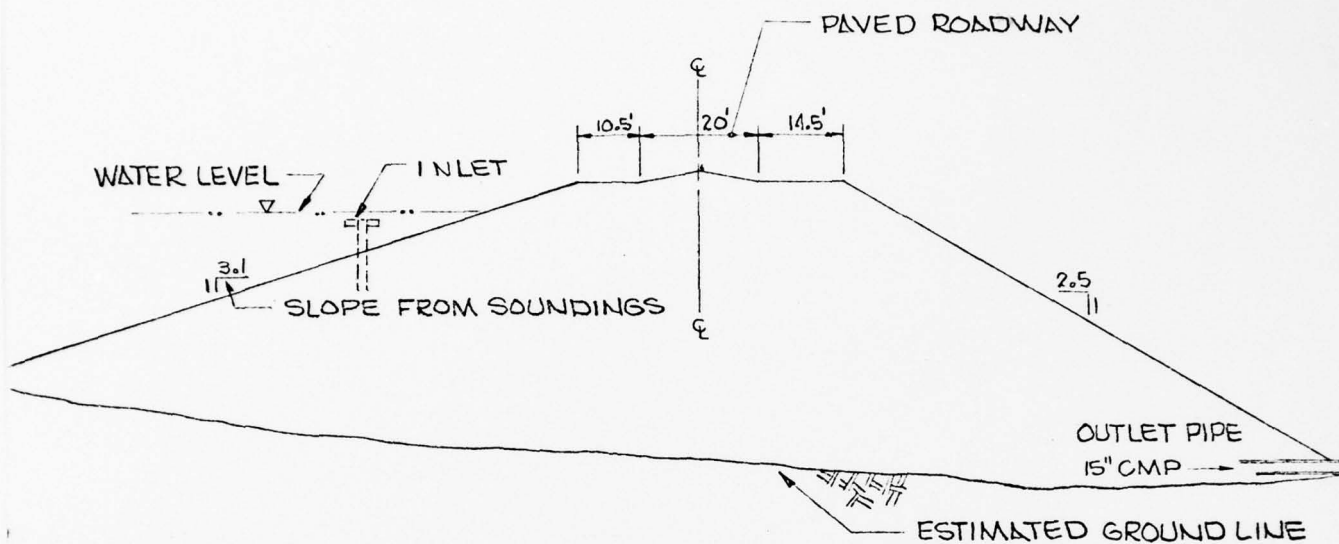
LOCATION PLAN
CRYSTAL



NOTE: NO EMERGENCY
DRAIN WAS FOUND

SKETCH MADE FROM FIELD
NOTES. NOT TO SCALE

MICHAEL BAKER JR. INC.
CRYSTAL LAKE DAM
PLATE I
8-15-78



TYPICAL SECTION
THRU EMBANKMENT

SKETCH MADE FROM FIELD NOTES.
NOT TO SCALE

MICHAEL BAKER JR. INC.
CRYSTAL LAKE DAM
PLATE II
8-15-78

APPENDIX II

PHOTOGRAPHS

CONTENTS

- Photo 1: Outlet Pipe at Toe of Embankment
- Photo 2: Inlet Pipe in Reservoir Submerged About 0.9 Foot
- Photo 3: Looking Upstream at Emergency Spillway From About 100 Feet Downstream
- Photo 4: Looking Downstream at Emergency Spillway From 100 Feet Downstream From Crest
- Photo 5: Looking Downstream at Emergency Spillway From Point in Line With Centerline Bearing
- Photo 6: Location of Sloughing at Top of Downstream Face (Looking Left)
- Photo 7: Swampy Area Just Downstream From Toe on Right Side of Embankment (Area Is About 150 Feet by 100 Feet.)
- Photo 8: Swampy Area Just Downstream From Toe on Right Side of Embankment (Area Is About 150 Feet by 100 Feet.)

Note: Photographs were taken 20 July 1978.

NAME OF DAM: CRYSTAL

CRYSTAL DAM



PHOTO 1. Outlet Pipe at Toe of Embankment

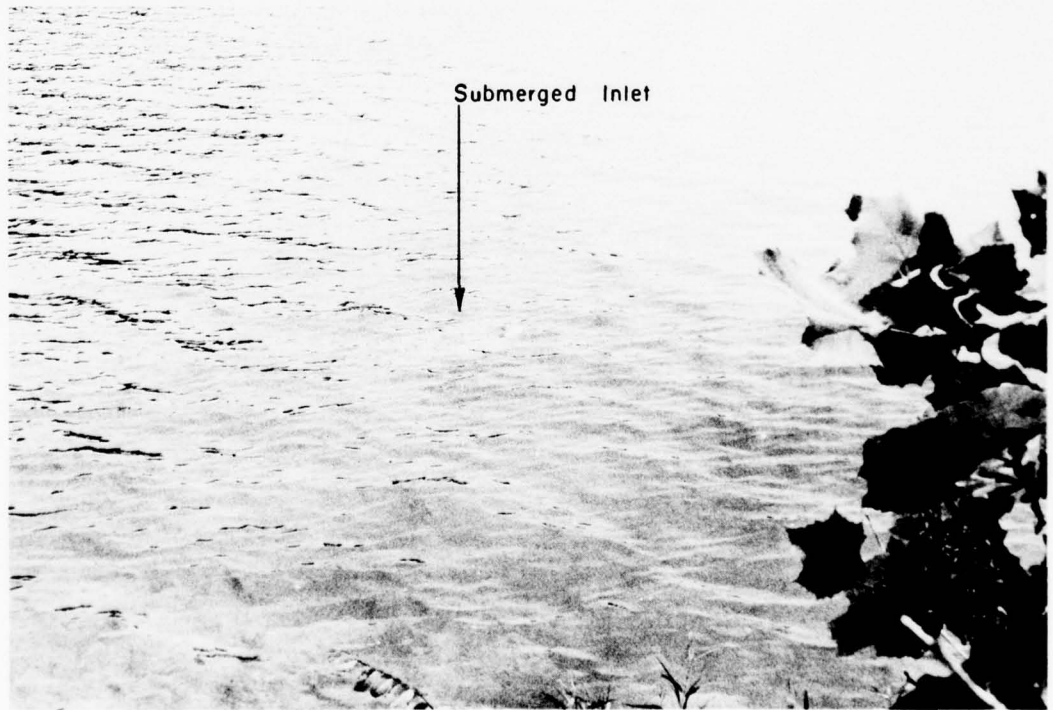


PHOTO 2. Inlet Pipe in Reservoir Submerged About 0.9 Foot

CRYSTAL DAM



**PHOTO 3. Looking Upstream at Emergency Spillway
From About 100 Feet Downstream**



**PHOTO 4. Looking Downstream at Emergency Spillway,
100 Feet Downstream From Crest**

CRYSTAL DAM



**PHOTO 5. Looking Downstream at Emergency Spillway
From Point in Line With Centerline Bearing**

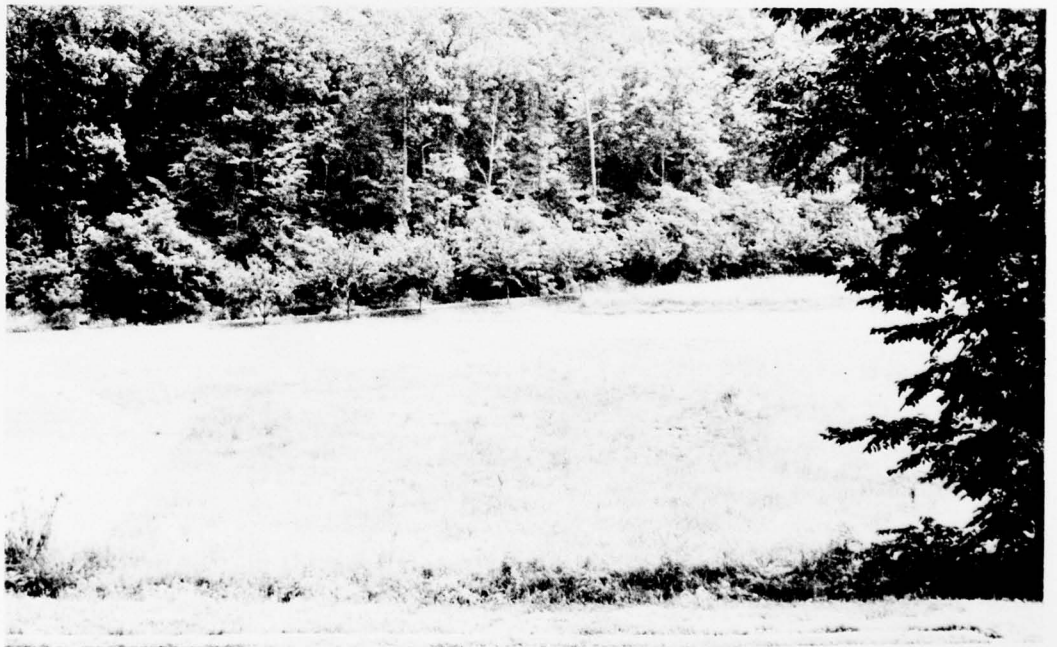


PHOTO 6. Location of Sloughing at Top of Downstream Face (Looking Left)

CRYSTAL DAM



**PHOTO 7. Swampy Area Just Downstream From Toe on Right Side of Embankment
(150 Feet by 100 Feet)**



**PHOTO 8. Swampy Area Just Downstream From Toe on Right Side of Embankment
(150 Feet By 100 Feet)**

APPENDIX III

CHECK LIST - VISUAL INSPECTION

Check List
Visual Inspection
Phase 1

Name Dam Crystal County Frederick State Virginia Coordinates Lat. 3911.2
Long. 2820.3

Date Inspection 20 July 1978 Weather Sunny, Hot Temperature 90°F.

Pool Elevation at Time of Inspection 1000.9 Local Datum Tailwater at Time of Inspection 958.4 Local Datum

HH-1

Inspection Personnel:

MICHAEL BAKER, JR., INC.:
E.L. Brill
J.M. Thompson
M. Mill

VIRGINIA WATER CONTROL BOARD:
T. Mizell
W. Lorenz

E.L. Brill Recorder

CRYSTAL

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION:	No outcrops were found that would indicate foundation conditions. Also, no plans or as-built drawings that would indicate foundation conditions were available.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No sloughing or erosion was observed at the junction of embankment and abutment, spillway and dam.	
	No outcrops were observed at the abutments; therefore, the geologic features of the abutments could not be determined.	
ANY NOTICEABLE SEEPAGE	A soft, wet area approximately 15 feet long and 10 feet wide was observed on the downstream slope at an elevation about 20 feet higher than the outlet pipe. This area is about 10 feet to the left of the outlet pipe. A large marshy area about 150 feet by 100 feet was observed about 15 feet beyond the toe to the right of the outlet channel. The source of the water in this area is unknown.	<p>1) Even though no flow was observed at the wet area on the downstream face of the dam, this area should be inspected periodically to prevent a worse condition from going unobserved.</p> <p>2) An additional investigation should be conducted to determine the cause of the marshy area beyond the toe.</p>
STAFF GAGE AND RECORDER	None were observed.	
DRAINS	None were observed.	

III-3

CRYSTAL

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not Applicable	
INTAKE STRUCTURE	The intake structure is a 15 inch vertical corrugated metal pipe capped by a metal strainer with one-half inch openings. Top of structure is approximately 0.9 feet below the water. Heavily rusted but otherwise apparently functioning properly.	Strainer may restrict flow enough to cause water level to rise above top of pipe. The pipe may also be blocked at some point between the ends.
OUTLET STRUCTURE	The 15 inch diameter corrugated metal pipe has no visible deterioration. Some erosion is visible due to the poor channel alignment and the small quantity of riprap at the outlet.	Improve channel alignment and provide adequate erosion protection.
OUTLET CHANNEL	Heavily overgrown with brush for approximately 75 feet downstream. Remainder of channel is well-maintained grass.	Periodically remove brush and debris.
EMERGENCY GATE	None, no reservoir drain was found.	A reservoir drain should be installed

CRYSTAL

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

CONCRETE WEIR

There is none.

APPROACH CHANNEL

Asphalt and gravel area used as a boat launching area. No significant erosion.

DISCHARGE CHANNEL

A severely eroded earth channel which runs immediately next to an asphalt road.

Regrade spillway with proper erosion control measures.

BRIDGE AND PIERS

There is none.

CRYSTAL

INSTRUMENTATION

<u>VISUAL EXAMINATION</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
MONUMENTATION/SURVEYS	None were observed.	
OBSERVATION WELLS	None were observed.	
WEIRS	None were observed.	
PIEZOMETERS	None were observed.	
OTHER	None were observed.	

CRYSTAL

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

SLOPES

No sloughing or erosion was observed.

SEDIMENTATION

Sedimentation was not measured.

III-7

CRYSTAL

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Well-maintained grass channel which flows into a pond approximately 500 feet downstream of the outlet.	
SLOPES	No erosion or sloughing was observed. Channel slope is approximately one percent.	
APPROXIMATE NO. OF HOMES AND POPULATION	A lodge which includes overnight guests and other recreational facilities are located approximately 600 feet downstream of the dam. It is estimated that about 50 people may be in the lodge at one time. A grocery store is located downstream at Clowser Gap.	

APPENDIX IV

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

CRYSTAL

ITEM	REMARKS
PLAN OF DAM	The plan of this dam was drawn from field measurements. No as-built drawings were available.
REGIONAL VICINITY MAP	The Location Plan was obtained from the U.S. Geological Survey map.
CONSTRUCTION HISTORY	The dam was built by the owner during the 1950's. No other data was available.
TYPICAL SECTIONS OF DAM	A typical section of the dam has been prepared using field measurements.
HYDROLOGIC/HYDRAULIC DATA	No hydrologic or hydraulic data was available.
OUTLETS - PLAN	None were available.
- DETAILS	None were available.
- CONSTRAINTS	None were available.
- DISCHARGE RATINGS	None were available.
RAINFALL/RESERVOIR RECORDS	No rainfall or reservoir records were available at the dam.

CRYSTAL

ITEM REMARKS

DESIGN REPORTS

None were available.

GEOLOGY REPORTS

None were available.

DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES

None were available.

IV-2

MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD

None were available.

POST-CONSTRUCTION SURVEYS OF DAM

None were available.

BORROW SOURCES

No records were available.

CRYSTAL

ITEM	REMARKS
MONITORING SYSTEMS	No system has been provided.
MODIFICATIONS	Unknown
HIGH POOL RECORDS	None were available.
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None were available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	There is no record of accidents or failures.
MAINTENANCE OPERATION RECORDS	None were available.

CRYSTAL

ITEM	REMARKS
------	---------

SPILLWAY PLAN	None were available.
---------------	----------------------

SECTIONS	None were available.
----------	----------------------

DETAILS	None were available.
---------	----------------------

OPERATING EQUIPMENT PLANS & DETAILS	None were available.
--	----------------------

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 518 acres

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 999.2 feet¹ (307 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1001.8 feet (354 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: 1006.2 feet

ELEVATION TOP DAM: 1006.2 feet

CREST: Emergency spillway

- a. Elevation 1001.8 feet
- b. Type Earth cut roadside channel
- c. Width 25 feet
- d. Length 500± feet
- e. Location Spillover Right abutment
- f. Number and Type of Gates None

OUTLET WORKS: _____

- a. Type 15 inch corrugated metal pipe riser with cylindrical trash rack.
- b. Location Riser in reservoir, metal pipe extending to outlet channel.
- c. Entrance inverts 999.2
- d. Exit inverts 957.9 (invert of 15 inch outlet pipe)
- e. Emergency draindown facilities None

HYDROMETEOROLOGICAL GAGES: None

- a. Type Not Applicable
- b. Location Not Applicable
- c. Records Not Applicable

MAXIMUM NON-DAMAGING DISCHARGE Not Known

¹All elevations are based on an assumed datum of 1000 feet at the top of the riser cap.

NAME OF DAM: CRYSTAL